

Micromycetes in archives and book depositories in the Czech Republic

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Species representation of micromycetes and their frequency were studied in the period 1981-1988 in four archives in Prague and near Prague and in one depository in West Bohemia. Representatives of genera *Penicillium*, *Cladosporium*, *Alternaria*, *Aspergillus*, *Mucor* and *Rhizopus* isolated by sediment plate method and from the surfaces of the archive depots were the most frequent in all observed spaces. The higher number of the most frequent species was always found in older and for the archive purposes less convenient buildings, while inside the new building the number of the most frequent species was very low. In suitable conditions only a limited number of species for which the given specific conditions are convenient, act as destructive. They are mostly penicillia which form coherent growing covers on the backs of the books and cartons. Spores of these fungi released by their growth contaminate the atmosphere of these spaces and can cause allergies in sensitive persons.

Key words: Micromycetes, archives, allergies, Czech Republic

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V letech 1981 - 1988 bylo sledováno druhové zastoupení mikromycetů i jejich frekvence ve 4 archivních budovách v Praze a v okolí Prahy a v knihovním depositáři v záp. Čechách. Ve všech sledovaných prostorách byly ze spadu i ze stěru archiválií nejčastěji izolováni zástupci r. *Penicillium*, *Cladosporium*, *Alternaria*, *Aspergillus*, *Mucor* a *Rhizopus*. Ve starších a pro archivní účely méně vhodných prostorách byl pravidelně zjištěn vyšší počet nejfrekventovanějších druhů, zatímco v prostorách nové budovy byly počty nejfrekventovanějších druhů velmi nízké. Za vhodných podmínek se destruktivně projeví jen omezený počet druhů, jimž dané podmínky vyhovují. Jsou to ponejvíce penicilia, která tvoří souvislé porosty na hřbetech knih a kartonů. Spóry těchto hub uvolňované z porostů na archiváliích zamořují ovzduší těchto prostor a mohou způsobovat alergie u citlivých jedinců.

INTRODUCTION

All over the world, a great attention is paid to studies on indoor fungi, especially in connection with mould allergies in household, as well as in some work places. This paper, presenting results from a less explored field, is devoted to moulds contaminating archives and book depositories where they cause biodegradation of archive material and in addition they can affect the staff health.

A certain tradition in studying archive fungi exists at the State Central Archive in Prague. This was due also to efforts of the physician and hygienist B. Skorkovský who elaborated a precise hygienic regime for archives and archive keepers published

later in the manual: Microorganisms as resources of degradation of archive material (1981) (in Czech).

The aim of my study was to establish micromycetes species representation in some archive rooms and books depositories, their extent and range of activities in connection with conditions of the examined spaces. Moulds isolation and determination were done in collaboration with my colleagues mycologists of the Department of Botany. Our first results have been published in 1987 (Fassatiová et al. 1987).

Robledo and Moretti (1986) report about 60 genera of fungi from archive material, the most frequent were *Penicillium*, *Aspergillus*, *Chaetomium* and *Phoma*. Kowalik (1980a, 1980b) studying microbiodeterioration in book material in Poland and examined various fungicides against micromycetes. The most resistant were: *Chaetomium globosum*, *Trichoderma viride*, *Fusarium* sp. and *Penicillium* sp. Samson (1985) briefly reports about the present strong mould contamination of some libraries and archives in the Netherlands. Gandjar et al. (1989) mention 32 species of micromycetes found in atmosphere and in archive material in Jakarta in Indonesia. The most frequent genera were *Aspergillus* and *Penicillium*.

MATERIAL AND METHODS

In the period 1981 - 1989 filamentous fungi were studied in three buildings of the State Central Archive, in the building of the archive of the city of Prague and in one depository of the National Library in West Bohemia. The only building constructed directly for archive purpose is the State Central Archive in Prague 6, the other ones are old historical objects inconvenient for archives. The Tab. 1 gives a survey of the observed buildings with their characteristics and abbreviations.

The sedimentation method marked as fall-out and the method wipping-off with cotton swab were used for isolation of micromycetes. The quality of species, their number, number of colonies as well as the most frequent species were analysed. Following media were used for isolation: soil agar with Bengal red and streptomycin, Sabouraud agar and malt-extract agar normal and with 40% saccharose (for osmophilic species). Special diagnostic media for identification were used.

Tab. 1 – Survey of the observed archives and book depositories

Abbreviation	Name	Locality	Time of construction	Purpose of building	Climatisation	Maintenance
SAP	State central archive	Prague 6	1930	archive	yes	very good
SAL	State central archive "Loreta"	Prague 1	16th-17th century	municipal administrative building, later prison, then college, since 1945 archive	none	bad
SAM	State central archive Mníšek	Mníšek near Prague	17th-18th century	castle, since 1943 archive	none	bad
AP	Archive of the city of Prague	Prague 1	18th century	palace, since 1945 archive	none	bad
DK	State library depository	Postoloprty (west Bohemia)	19th century	castle, since 1988 depository	partial	partial

CONCLUSIONS

Isolated species in different archive buildings with total numbers and the numbers obtained with both isolation methods are given in Tab. 2.– 8.

Following facts are important for evaluation of internal conditions of archives and book depositories from point of view of micromycetes occurrence: 1. Total number of found species, 2. Average number of colonies obtained from both isolation methods, 3. Number of the most frequent species. The difference in number of species obtained by individual isolation method was not significant in individual localities, also the quality of species differed only slightly. The higher number of the most frequent species was always found in older and for the archive purposes less convenient buildings, while inside the new building or in the building with the equipment for stable R.H., the number of the most frequent species was very low (Tab. 7., 8.). It was found out, that in suitable conditions only a limited number of present species of micromycetes act as destructive. In the old and very badly maintained building: archive of the city of Prague, moulds were growing on the backs of the archive materials following the orientation of air draughts from window or humidity source towards the door. They are mostly penicillia which form coherent growing covers on the back of the books and cartons. The most frequent species of all archive buildings studied were *Penicillium aurantiogriseum*, *Alternaria alternata*, *Cladosporium herbarum*, *Cl. cladosporioides*, *Aspergillus versicolor* and *Aspergillus*

of the group *glaucus*. The predominance of the genera *Penicillium* and *Aspergillus* corresponds also with the results of other authors. Spores of these fungi present in a large extent in the atmosphere of that rooms may cause allergies of the archive staff and the visitors. After two hours of presence in the depository of one library, I was affected, as well as my colleague, by bronchitis lasting several days. Relative humidity of 68% does not prevent in these spaces growing of osmophilic species of *Aspergillus glaucus* group on the archive surfaces. For that reason, it is necessary within the regular maintenance of the archive regime, to apply a desinfectory means to book backs. A good effect in that sense was found when using Lastanox Q in slight alcohol solution (produced by Lachema in Czech Republic).

Tab. 2 – State central archive (SAP) in Prague 6

Building constructed for archive purposes, very well maintained archive spaces, regulary cleaning up, equipment for maintaining stable R.H. below 65 %, archive materials mostly on metal shelves.

Isolated species		<i>Alternaria alternata</i> <i>Aspergillus ustus</i> <i>Cladosporium cladosporioides</i> <i>C. herbarum</i> <i>C. sphaerospermum</i> <i>Mucor plumbeus</i> <i>M. racemosus</i> <i>Penicillium aurantiogriseum</i> <i>P. brevicompactum</i> <i>P. chrysogenum</i> <i>P. citrinum</i> <i>P. corylophilum</i> <i>P. glabrum</i> <i>P. griseofulvum</i> <i>P. roquefortii</i>
Total no. of species		15
No. of species	– fall-out	9
	– wiping out	10
Average no. of colonies		5

Tab. 3 – State central archive "Loreta" (SAL) in Prague 1

Old building unsuitable for archive, moist walls in the ground-floor, without equipment for maintaining reduced humidity, R.H. 70 – 75%. Archive materials on wooden shelves.

Isolated species	<i>Acremonium butyri</i>	<i>Paecilomyces</i> sp.
	<i>Acremonium</i> sp.	<i>Penicillium aurantiogriseum</i>
	<i>Alternaria alternata</i>	<i>P. brevicompactum</i>
	<i>Alternaria</i> sp.	<i>P. chrysogenum</i>
	<i>Arthrinium phaeospermum</i>	<i>P. commune</i>
	<i>Aspergillus fumigatus</i>	<i>P. expansum</i>
	<i>Aspergillus</i> gr. <i>glaucus</i>	<i>P. glabrum</i>
	<i>A. niger</i>	<i>P. griseofulvum</i>
	<i>A. versicolor</i>	<i>P. luteum</i>
	<i>Aureobasidium pullulans</i>	<i>P. roquefortii</i>
	<i>Botrytis cinerea</i>	<i>P. variable</i>
	<i>Cladosporium cladosporioides</i>	<i>P. viridicatum</i>
	<i>C. herbarum</i>	<i>Phoma</i> sp.
	<i>C. sphaerospermum</i>	<i>Rhizopus arrhizus</i>
	<i>Epicoccum purpurascens</i>	<i>R. stolonifer</i>
	<i>Fusarium</i> sp.	<i>Scytalidium</i> sp.
	<i>Chaetomium globosum</i>	<i>Trichoderma viride</i>
Total no. of species		34
No. of species	– fall-out	30
	– wiping off	32
Average no. of colonies		35

Tab. 4 – State central archive in Mníšek near Prague (SAM)

Old building unsuitable for archive purposes, ground floor with moist walls, space insufficiently maintained. Wooden shelves. R.H. 70-75%.

Isolated species	<i>Acremonium strictum</i>	<i>Drechslera sativa</i>
	<i>Alternaria alternata</i>	<i>Epicoccum purpurascens</i>
	<i>A. tenuissima</i>	<i>Humicola fuscoatra</i>
	<i>Arthrinium phaeospermum</i>	<i>Mucor plumbeus</i>
	<i>Aspergillus flavus</i>	<i>Oidiodendron</i> sp.
	<i>A. fumigatus</i>	<i>Penicillium aurantiogriseum</i>
	<i>Aspergillus</i> gr. <i>glaucus</i>	<i>P. brevicompactum</i>
	<i>A. niger</i>	<i>P. chermesinum</i>
	<i>A. ochraceus</i>	<i>P. citrinum</i>
	<i>A. ustus</i>	<i>P. corylophilum</i>
	<i>A. versicolor</i>	<i>P. glabrum</i>
	<i>Aureobasidium pullulans</i>	<i>P. griseofulvum</i>
	<i>Chaetomium globosum</i>	<i>P. janthinellum</i>
	<i>Chrysosporium pannorum</i>	<i>P. lanosum</i>
	<i>Cladosporium cladosporioides</i>	<i>P. variable</i>
	<i>C. herbarum</i>	<i>Phoma</i> sp.
	<i>C. macrocarpum</i>	<i>Rhizopus arrhizus</i>
<i>C. sphaerospermum</i>	<i>Ulocladium botrytis</i>	
<i>Cunninghamella elegans</i>		
Total no. of species		37
No. of species	– fall-out	24
	– wiping off	24
Average no. of colonies		36

Tab. 5 – Archive of the city of Prague (AP), Prague 1

Old building unsuitable for archive, in ground-floor moist walls, in some places water is leaking into the rooms when raining, insufficient ventilation, in ground-floor archive materials partly stocked on piles, in the first floor partly tidied, archive materials mostly on wooden shelves. R.H. 72-86%.

Isolated species	Acremonium sp.	Mucor circinelloides
	Alternaria alternata	M. plumbeus
	Alternaria sp.	M. racemosus
	Aspergillus candidus	Paecilomyces fumosoroseus
	A. clavatus	Penicillium aurantiogriseum
	A. flavus	P. brevicompactum
	Aspergillus gr. glaucus	P. caseicolum
	A. fumigatus	P. chermesinum
	A. nidulans	P. chrysogenum
	A. versicolor	P. commune
	Aureobasidium sp.	P. corylophilum
	Beauveria bassiana	P. expansum
	Botryotrichum piluliferum	P. glabrum
	Botrytis cinerea	P. griseofulvum
	Chrysosporium pannorum	P. lanosum
	Ch. pruinatum	P. roquefortii
	Cladosporium cladosporioides	P. roseopurpureum
	C. herbarum	P. variable
	Chaetomium globosum	Phoma sp.
	Epicoccum purpurascens	Rhizopus arrhizus
	Geotrichum candidum	Scopulariopsis brevicaulis
	Monodictys sp.	Trichoderma viride
	Mortierella sp.	Ulocladium botrytis
Total no. of species		46
No. of species	– fall-out	32
	– wiping off	37
Average no. of colonies		40

Tab. 6 – State library depository (DK), Postoloprty (West Bohemia)

Old building inconvenient for book deposits, rooms tidied up, equipment for humidity control, books on wooden shelves. R.H. 65 – 68%.

Isolated species		<i>Alternaria alternata</i> <i>A. tenuissima</i> <i>Alternaria</i> sp. <i>A. corymbifera</i> <i>Aspergillus flavus</i> <i>Aspergillus</i> gr. <i>glaucus</i> <i>A. niger</i> <i>A. versicolor</i> <i>Aureobasidium pullulans</i> <i>Botrytis cinerea</i> <i>Chaetomium globosum</i> <i>Cladosporium cladosporioides</i> <i>C. herbarum</i> <i>C. sphaerospermum</i> <i>Penicillium aurantiogriseum</i> <i>P. chrysogenum</i>
Total no. of species		16
No. of species	– fall-out	15
	– wiping off	11
Average no. of colonies		4

Tab. 7 - The most frequent species in individual archives and book depositories

SAP	Cladosporium cladosporioides C. herbarum Penicillium aurantiogriseum
SAL	Alternaria alternata Aspergillus niger A.versicolor Botrytis cinerea Cladosporium cladosporioides C. herbarum Penicillium aurantiogriseum
SAM	Alternaria alternata Aspergillus versicolor Chrysosporium pannorum Cladosporium cladosporioides C. herbarum Mucor plumbeus Penicillium aurantiogriseum
AP	Aspergillus gr. glaucus A. versicolor Cladosporium cladosporioides Mucor plumbeus Penicillium aurantiogriseum P. chrysogenum P. griseofulvum Rhizopus arrhizus Trichoderma viride
DK	Aspergillus gr. glaucus Chaetomium globosum Cladosporium cladosporioides Penicillium aurantiogriseum

Tab. 8 – Comparison of internal technical equipment of individual archives with total number of isolated species and number of the most frequent species

Archive	Year of study	No. of observed rooms	Maintenance	Climatisation	R.H.	No. of isolated species	No. of the most frequent species
SAP	1985	7	very good	yes	under 64%	15	3
SAL	1985	6	bad	no	72-78%	34	7
SAM	1985	7	bad	no	70-75%	36	7
AP	1981	8	bad	no	72-86%	46	9
DK	1988	7	partial	yes	60-67%	16	4

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